REMARKS

Claims 1-44 are pending in the application. In the Office Action at hand, Claims 1-44 are rejected.

Claim 20 has been amended to be dependent upon Claim 12, and therefore overcomes the Examiner's objection as being the same as Claim 9.

Claims 1, 2, 8, 9, 20, 41 and 42 are rejected under 35 U.S.C. § 102(b) as being anticipated by Nakano (JP 11052098A). In addition, Claims 3, 6, 7 and 11 are rejected under 35, U.S.C. § 103(a) as being unpatentable over Nakano in view of Avnery (U.S. 5,962,995). Furthermore, Claims 4, 5 and 10 are rejected under Section 103(a) as being unpatentable over Nakano in view of Avnery and Lyons (U.S. 5,415,440). Also, Claims 12-14 and 17-19 are rejected under Section 103(a) as being unpatentable over Avnery in view of Nakano. Finally, Claims 15 and 16 are rejected under Section 103(a) as being unpatentable over Avnery in view of Nakano and Lyons. Finally, method Claims 21-40, 43 and 44 are rejected in the same manner as their respective apparatus claims. In response to the Section 102(b) and 103(a) rejections, the Applicant respectfully submits that Claims 1-44, as amended, are neither anticipated nor obvious in view of Nakano, Avnery and Lyons. Reconsideration is respectfully requested.

The present invention as recited in Claim 1, as amended, is directed to an exit window for an electron beam emitter through which electrons pass in an electron beam. The exit window includes an exit window foil of titanium about 12 microns thick or less having an interior and an exterior surface. A corrosion resistant layer having high thermal conductivity is formed over the exterior surface of the exit window foil for resisting corrosion and increasing thermal conductivity.

Claim 21, as amended, is a method claim which generally parallels Claim 1, as amended. Claim 12, as amended, specifies an electron beam emitter and Claim 32, as amended, is a method claim which generally parallels Claim 12, as amended. In addition, Claim 10 recites an "exit window foil comprising titanium about 6 to 12 microns thick and the corrosion resistant layer comprising gold about .1 to 1 microns thick", and Claim 11 recites an "exit window foil

comprising titanium about 6 to 12 microns thick and the corrosion resistant layer comprising diamond about .25 to 2 microns thick". Claims 30 and 31 are method claims which generally parallel Claims 10 and 11, respectively.

Apparatus Claim 41 and method Claim 43, as amended, specify "an exit window foil of titanium about 12 microns thick or less" and "the thickness of the corrosion resistant layer being about 4% to 8% the thickness of the exit window foil". Apparatus Claim 42 and method Claim 44, as amended, specify "an exit window foil of titanium" and a "corrosion resistant layer of diamond".

Claims 1, 12, 21, 32, 41 and 43 have been amended to recite "an exit window foil of titanium about 12 microns thick or less", and Claims 42 and 44 have been amended to specify "an exit window foil of titanium". Support for these amendments is found at least on page 2, lines 14-15, and page 9, lines 15-17 of the Specification as originally filed. No new matter is introduced.

In the present invention, for example, referring to FIG. 10, an exit window foil 32a, for example, formed of titanium about 12 microns thick or less (typically 6 to 12 microns thick), is advantageous in that electrons can pass through the exit window foil 32a at higher intensities than through standard thickness exit window foils which are typically above 13 microns. The tradeoff for having a thinner exit window foil 32a is that the electron beam passing through the exit window foil 32a can more easily burn a hole through it. Often, a reduction in electron beam power is required to prevent the electron beam from burning such a hole. In cases where the exit window foil 32a is made of titanium, which has a relatively low thermal conductivity, the Applicant has found that a layer of corrosion resistant high thermal conductive material 32b on the exterior surface of the lower thermal conductive exit window foil 32a can increase the overall thermal conductivity of the exit window 32 so that heat generated by the electron beam passing therethrough can be more rapidly conducted away. As a result, the electron beam intensity does not need to be reduced to prevent burning a hole in the thinner exit window foil 32a, and in some cases, the intensity can be increased. In addition, by employing a layer of high thermal

conductive material 32b that is also corrosion resistant on the exterior surface of exit window foil 32a, the layer of high thermal conductive material 32b and the exit window 32 experience little or no corrosion. Depending upon the materials used for the layer of high thermal conductive material 32b, as well as the thicknesses chosen for both the exit window foil 32a and the layer of high thermal conductive material 32b, the addition of the high thermal conductive material 32b can often increase the overall thermal conductivity of the exit window 32, for example, formed of titanium, over that of the exit window foil 32a alone, by a factor ranging from about 2 to 8.

In one embodiment, the exterior surface of the exit window foil 32a is covered with a layer of diamond as the high thermal conductive corrosion resistant material 32b. The layer of diamond is corrosion resistant so that the exit window foil 32a and the exit window 32 experience little or no corrosion during use. With the layer of diamond, a 6 micron titanium exit window foil 32a that would normally only be capable of withstanding power of about 4 kW, can withstand power of up to 20 kW. Although the thickness of the exit window foil 32a is typically 6 to 12 microns thick for obtaining high transmission of electrons therethrough, exit window foil thicknesses above 12 microns may be employed for operating at high power levels. The layer of diamond is typically in the range of .25 to .2 microns thick for maximizing thermal conductivity while at the same time minimizing the decrease in electron transmission through the exit window 32 due to the addition of the layer 32b. The thickness of the diamond layer can be chosen depending upon the operating power, the thickness of the exit window, etc. In some situations, the layer of diamond is about 4% to 8% the thickness of the exit window foil. Diamond has a relatively low density for a material having high thermal conductivity, which helps minimize the decrease of electron transmission through the exit window 32.

In other embodiments, the corrosion resistant high thermal conductive layer can be a high density material such as gold. Normally, gold would not be considered desirable for such a layer because the high density of gold tends to impede the transmission of electrons therethrough. The Applicant has found that by employing a layer 32b of gold about .1 to 1 micron thick over the exterior surface of a titanium exit window foil 32a, the thermal conductivity of the exit window

foil 32a can be maximized while minimizing the impedance of the electrons. In some situations, the thermal conductivity of the exit window can be increased by a factor of about 2.

In contrast, Nakano discloses a window foil formed of aluminum and having a thin coating of titanium and further including a thin hard coating over the titanium coating. A translation of Nakano is enclosed. Page 6, lines 3-9 of the translation of Nakano discloses that the aluminum foil has a thickness of 5-20 μm with 10-15 μm being preferred. In order to prevent corrosion of the aluminum foil (page 6, lines 13-15) a thin layer of titanium covers the aluminum in the range of .03-1 μm thick (page 6, lines 29-30). The titanium layer requires a hard coating with abrasion resistance and sufficient hardness to protect the titanium layer (page 6, lines 18-20) since the thin titanium layer often has defects (page 4, lines 26-29). The hard coating is in the range of .03-1 μm thick (page 6, lines 29-31) which is the same thickness range of the titanium layer. The hard coating is preferably TiN but can be diamond. The last two lines on page 8 of the translation of Nakano discloses that increased electron beam transmission is obtained when the window foil base material is aluminum foil rather than titanium foil, and teaches against employing a base foil of titanium.

may be better [illegible] [illegible] [illegible]

Accordingly, Claims 1, 2, 8, 9, 20, 41 and 42, as amended, are not anticipated in view of Nakano since Nakano does not teach or suggest "an exit window foil of titanium about 12 microns thick or less *having an interior and exterior surface*", and "a corrosion resistant layer having high thermal conductivity formed over the exterior surface of the exit window foil", as recited in independent Claims 1, 12 and 41, as amended, or "an exit window foil of titanium having *an interior and an exterior surface*; and a corrosion resistant layer having high thermal conductivity formed over the exterior surface of the exit window foil . . . the corrosion resistant layer comprising diamond", as recited in independent Claim 42, as amended. In Nakano, the exit window base foil is formed of aluminum which, Nakano teaches, has improved electron transmission and thermal conductivity over titanium. The layer of titanium in Nakano merely protects the aluminum base foil. The layer of protective titanium .03-1 μm thick covering the aluminum is too thin to have sufficient strength to withstand vacuum forces to function independently as an exit window foil and therefore cannot be considered an exit window foil. In

addition, the thin layer of titanium formed over the aluminum base foil does not form a titanium exit window having an *interior surface*. The interior surface of the exit window is formed by a surface of the aluminum base foil. Therefore, Claims 1, 2, 8, 9, 20, 41 and 42, as amended, are in condition for allowance. Reconsideration is respectfully requested.

Avnery (U.S. 5,962,995) discloses an exit window foil of about 6-12 microns thick formed from a number of materials, including titanium. Avnery does not disclose forming a layer of material over the exit window foil. As discussed above, Nakano teaches against employing titanium as the exit window base foil in favor of aluminum due to increased electron transmission, and therefore teaches against combining Nakano with Avnery to employ a titanium exit window base foil. Accordingly, Claims 3, 6, 7 and 11 are not obvious in view of Nakano and Avnery, since Nakano and Avnery together do not teach or suggest "an exit window foil of titanium about 12 microns thick or less having an interior and exterior surface; and a corrosion resistant layer having high thermal conductivity formed over the exterior surface of the exit window foil", as recited in base Claim 1, as amended, and similar limitations recited in independent Claim 11. Therefore, Claims 3, 6, 7 and 11 are in condition for allowance. Reconsideration is respectfully requested.

Lyons discloses on column 11, line 8, the use of a thin titanium foil window and on column 18, lines 54-58, that exit windows can be coated with a thin layer of gold. However, Lyons does not disclose the thickness of the layer of gold. Column 21, line 67 through column 22, line 1, discloses a titanium window .001 inch thick (25.4 microns). As a result, Lyons discloses an exit window much thicker than 12 microns and does not disclose that the layer of gold can be about .1 to 1 microns thick to conduct heat from the exit window while at the same time not substantially impeding the passage of electrons therethrough.

Accordingly, Claims 4, 5 and 10 are not obvious in view of Nakano, Avnery and Lyons, since Nakano teaches against combining with Avnery to employ a titanium exit window base foil as discussed above, and Lyons in combination with Nakano and Avnery further does not teach or suggest "an exit window foil of titanium about 12 microns thick or less *having an interior and*

exterior surface; and a corrosion resistant layer having high thermal conductivity formed over the exterior surface of the exit window foil", as recited in base Claim 1, as amended, or a corrosion resistant layer of gold "about .1 to 1 microns thick", as further recited in dependent Claim 5, or an "exit window foil comprising titanium about 6 to 12 microns thick and the corrosion resistant layer comprising gold about .1 to 1 microns thick", as recited in independent Claim 10. Therefore, Claims 4, 5 and 10 are in condition for allowance. Reconsideration is respectfully requested.

In view of the above discussion, it follows that Claims 12-14 and 17-19, as amended, are also not obvious in view of Nakano and Avnery, since, as discussed above, Nakano and Avnery together do not teach or suggest "an exit window foil of titanium about 12 microns thick or less having an interior and an exterior surface, and a corrosion resistant layer having high thermal conductivity formed over the exterior surface of the exit window foil", as recited in base Claim 12, as amended. Therefore, Claims 12-14 and 17-19, as amended, are in condition for allowance. Reconsideration is respectfully requested.

In addition, it also follows that dependent Claims 15 and 16 are not obvious in view of Avnery, Nakano and Lyons, since Nakano, Avnery and Lyons together do not teach or suggest "an exit window foil of titanium about 12 microns thick or less having an interior and an exterior surface, and a corrosion resistant layer having high thermal conductivity formed over the exterior surface of the exit window foil", as recited in base Claim 12, as amended, or a corrosion resistant layer of gold "about .1 to 1 microns thick", as recited in dependent Claim 16. Therefore, Claims 15 and 16 are in condition for allowance. Reconsideration is respectfully requested.

Finally, method Claims 21-40, 43 and 44, as amended, generally parallel Claims 1-20, 41 and 42, as amended. In view of the above arguments, it follows that Claims 21-40, 43 and 44, as amended, are in condition for allowance. Reconsideration is respectfully requested.

CONCLUSION

In view of the above amendments and remarks, it is believed that all claims are in condition for allowance, and it is respectfully requested that the application be passed to issue. If the Examiner feels that a telephone conference would expedite prosecution of this case, the Examiner is invited to call the undersigned at (978) 341-0036.

Respectfully submitted,

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MARKED UP VERSION OF AMENDMENTS

Claim Amendments Under 37 C.F.R. § 1.121(c)(1)(ii)

1. (Twice Amended) An exit window for an electron beam emitter through which electrons pass in an electron beam, the exit window comprising:

an exit window foil <u>of titanium</u> about 12 microns thick or less having an interior and an exterior surface; and

a corrosion resistant layer having high thermal conductivity formed over the exterior surface of the exit window foil for resisting corrosion and increasing thermal conductivity.

12. (Twice Amended) An electron beam emitter comprising:

a vacuum chamber;

an electron generator positioned within the vacuum chamber for generating electrons; and

an exit window on the vacuum chamber through which the electrons exit the vacuum chamber in an electron beam, the exit window comprising an exit window foil <u>of titanium</u> about 12 microns thick or less having an interior and an exterior surface, and a corrosion resistant layer having high thermal conductivity formed over the exterior surface of the exit window foil for resisting corrosion and increasing thermal conductivity.

20. (Amended) The emitter of Claim [1] <u>12</u> in which the corrosion resistant layer includes a material having a density above .1 lb./in.^{3} and thermal conductivity above 300 W/m·k.

21. (Twice Amended) A method of forming an exit window for an electron beam emitter through which electrons pass in an electron beam comprising:

providing an exit window foil <u>of titanium</u> about 12 microns thick or less having an interior and an exterior surface; and

forming a corrosion resistant layer having high thermal conductivity over the exterior surface of the exit window foil for resisting corrosion and increasing thermal conductivity.

32. (Twice Amended) A method of forming an electron beam emitter comprising:

providing a vacuum chamber;

positioning an electron generator within the vacuum chamber for generating electrons; and

mounting an exit window on the vacuum chamber through which the electrons exit the vacuum chamber in an electron beam, the exit window comprising an exit window foil <u>of titanium</u> about 12 microns thick or less having an interior and an exterior surface, and a corrosion resistant layer having high thermal conductivity formed over the exterior surface of the exit window for resisting corrosion and increasing thermal conductivity.

41. (Amended) An exit window for an electron beam emitter through which electrons pass in an electron beam, the exit window comprising:

an exit window foil <u>of titanium about 12 microns thick or less</u> having an interior and an exterior surface; and

a corrosion resistant layer having high thermal conductivity formed over the exterior surface of the exit window foil for resisting corrosion and increasing thermal conductivity, the exit window foil and the corrosion resistant layer each having a thickness, the thickness of the corrosion resistant layer being about 4% to 8% the thickness of the exit window foil.

42. (Amended) An exit window for an electron beam emitter through which electrons pass in an electron beam, the exit window comprising:

an exit window foil <u>of titanium</u> having an interior and an exterior surface; and

a corrosion resistant layer having high thermal conductivity formed over the exterior surface of the exit window foil for resisting corrosion and increasing thermal conductivity, the corrosion resistant layer comprising diamond.

43. (Amended) A method of forming an exit window for an electron beam emitter through which electrons pass in an electron beam comprising:

providing an exit window foil <u>of titanium about 12 microns thick or less</u> having an interior and an exterior surface; and

forming a corrosion resistant layer having high thermal conductivity over the exterior surface of the exit window foil for resisting corrosion and increasing thermal conductivity, the exit window foil and the corrosion resistant layer each having a thickness, the thickness of the corrosion resistant layer being about 4% to 8% the thickness of the exit window foil.

44. (Amended) A method of forming an exit window for an electron beam emitter through which electrons pass in an electron beam comprising:

providing an exit window foil <u>of titanium</u> having an interior and an exterior surface; and

forming a corrosion resistant layer having high thermal conductivity over the exterior surface of the exit window foil for resisting corrosion and increasing thermal conductivity, the corrosion resistant layer comprising diamond.